

B R E V I O R A

Museum of Comparative Zoology

CAMBRIDGE, MASS.

MAY 28, 1962

NUMBER 157

A RHACHITOMOUS AMPHIBIAN, *SPATHICEPHALUS*, FROM THE MISSISSIPPIAN OF NOVA SCOTIA

BY DONALD BAIRD

Department of Geology, Princeton University,
Princeton, New Jersey

In the past few years field parties from the Museum of Comparative Zoology at Harvard College, supported in part by funds from the National Science Foundation, have discovered several deposits of fossil amphibians which date from the earlier half of the Carboniferous period. Most of the material recovered comes from redbeds of the Upper Mississippian Mauch Chunk group in West Virginia (Romer, 1941) and Pennsylvania; more recently, amphibians have been found in beds of equivalent age at two sites in Nova Scotia.

In continuation of the Harvard collecting program, field parties sponsored jointly by Princeton University and the Nova Scotia Museum of Science have collected additional bones and trackways of amphibians in Pennsylvanian as well as Mississippian beds. One of these finds is noteworthy because no member of the order Temnospondyli from the Mississippian system has hitherto been described.

This specimen, the right half of a skull table preserved as a natural mold, comes from the same horizon and locality as the embolomeric lower jaw described as *Pholidrpeton*(?) *bretonense* Romer (1958). The matrix is a flaggy calcareous siltstone characterized by well-sorted quartz grains and silvery muscovite mica.

Superorder LABYRINTHODONTIA

Order TEMNOSPONDYLII

Suborder RHACHITOMI¹

Family LOXOMMIDAE

Genus SPATHICEPHALUS Watson 1929

[*Spathiocephalus* Romer 1945, *errore*]

Emended Diagnosis. A loxommid extremely specialized in its expanded cheek and snout, constricted interorbital area and shortened skull table, and having numerous small, chisel-shaped marginal teeth.

SPATHICEPHALUS PEREGER, n. sp.

Diagnosis. Differs from *S. mirus* Watson, the only other known species, in its relatively narrower skull table.

Type. PU 17182, Princeton University Geological Museum.

Occurrence. Point Edward formation, Canso group, Upper Mississippian (probably early Namurian). Beach of cove between Point Edward and Keating Cove, 4 miles northwest of Sydney, Cape Breton County, Nova Scotia. Collected by Donald Baird, William F. Take and Jane McN. Take, 1960.

DESCRIPTION

The dorsal surface of the skull table bears a deep, coarsely reticular sculpture rather similar to that of *Megalocephalus lincolatus* (Cope) but with narrower ridges. Aside from the separation of prefrontal from postfrontal, the contacts between skull elements are normal for a loxommid.

The narrow frontal bone is bounded medially by a deep, straight suture which is ridged rather like the edge of a file. Anteriorly the frontal is beveled to receive the end of the nasal; anterolaterally it bears a long, striated facet for the articulation of the prefrontal. As in other loxommids the prefrontal must have swelled laterally to form the antorbital process which dif-

¹ Assignment of the Loxommidae to the Rhachitomi is now confirmed by the association of rhachitomous vertebrae with a skull of *Megalocephalus lincolatus* (Cope) from Linton, Ohio (cf. Baird, 1957).

ferentiates the orbit proper from its anterior extension, the lacrima fenestra, and gives the loxommid eye-socket its characteristic keyhole shape. Most of the lateral edge of the frontal forms the thick orbital rim. At its waist the frontal is 4.3 mm. wide, making the interorbital distance a mere 8.6 mm. — extraordinarily narrow for a skull with an estimated width of 185 mm.

The short parietal extends laterally into a square lappet; there is no indication that this lappet represents a former intertem-

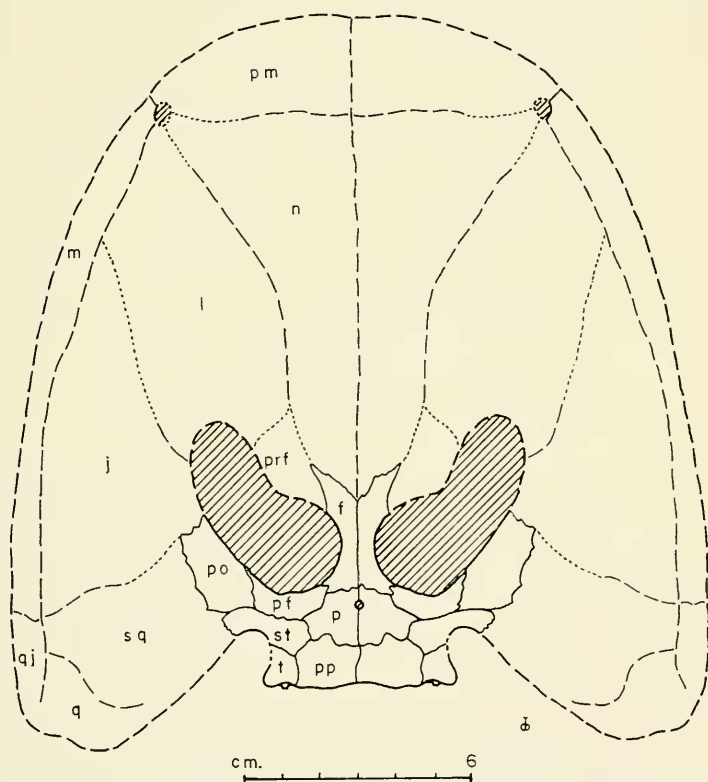


Fig. 1. Skull of *Spathicephalus pereger*, n. sp., $\times 1\frac{1}{2}$. Restoration in dashed lines based on *S. mirus*; dotted lines conjectural. Abbreviations: *f*, frontal; *j*, jugal; *l*, lacrima; *m*, maxilla; *n*, nasal; *p*, parietal; *pf*, postfrontal; *pm*, premaxilla; *po*, postorbital; *pp*, postparietal; *prf*, prefrontal; *q*, quadrate; *qj*, quadratojugal; *sq*, squamosal; *st*, supratemporal; *t*, tabular.

poral element. Centered in the anterior half of the inter-parietal suture lies the parietal foramen, 2.3 mm. in diameter, which housed the parapineal eye. The postparietal (dermal supraoccipital) is relatively large.

A thin oval lamina slopes outward from the corner of the tabular. Ventromedial to this flange lies the backward-jutting tubercle which is characteristic of loxommid tabulars but which also occurs in such genera as *Edops* (Romer and Witter, 1942). Whether this process is a true homolog of the tabular horn in other labyrinthodonts and perhaps of the tabular lamina in *Acanthostega* remains to be determined. Unfortunately, the lateral margins of the tabular and supratemporal are not clearly defined in the specimen. The greatly broadened supratemporal, however, is evidently embayed by the apex of the otic notch — a condition also found in *Baphetes* and *Megaloecephalus brevicornis* [*Orthosaurus pachycephalus* of Watson, 1926].

The postfrontal, which in most labyrinthodonts lies postero-medial to the orbit, here lies directly posterior to it. In consequence the postorbital has been thrust outward onto the cheek along with most of the supratemporal; its orbital margin is 19 mm. long and nearly straight. In its new orientation the post-orbital might be called exceptionally long rather than exceptionally broad.

Watson's (1929, fig. 22) illustration of the skull of *Spathicephalus mirus*, scaled to the interorbital width and post-orbital length of *S. pereger*, forms the basis for the reconstruction in Figure 1. The restored skull of *S. pereger* measures 177 mm. in mid-sagittal length as compared to 198 mm. for the type skull of *S. mirus*. As nothing is known of the postcranial skeleton in this genus, the dimensions of the whole animal cannot be estimated.

COMPARISON

Inconsistencies between the Point Edward specimen and the published account of *Spathicephalus mirus* might be interpreted as generic distinctions. Many of the discrepancies, however, can be attributed to differences in the manner and quality of preservation. For example, the suture pattern illustrated by Watson is that of the ventral surface of the skull roof and can be expected to differ somewhat from that of the dorsal surface.

The single element labeled "postorbital" in Watson's figure of *S. mirus* occupies the position of the postfrontal and half of the postorbital in *S. pereger*. Since the suture between jugal and squamosal meets the outer corner of this element — as it does the corner of the postorbital in all known loxommids — Watson's identification must be correct. If (as he suggests) the postfrontal forms part of the undifferentiated interorbital bar in *S. mirus*, then the two species differ markedly in this respect. Watson illustrates a suture which bisects the antorbital process at right angles to the lateral margin of the nasal bone, and interprets this suture as separating the lacrima from a wing of the interorbital bar. New evidence now permits a more conventional reconstruction of this region. No parietal foramen was observed in the Scottish material, but a foramen of normal size and position is evident in the Nova Scotian specimen.

One clear distinction lies in the relatively narrower skull table of the new species: in *S. mirus* the ratio of interorbital width to table width is 1:7 while in *S. pereger* it is 1:6. Another difference is that even when allowance is made for post-mortem distortion of the cheek region, the orbits seem to have been more obliquely placed in *S. pereger* than in *S. mirus*.

DERIVATION OF SPATHICEPHALUS

Grotesquely modified though it is, the skull structure of *Spathicephalus* (as elucidated by the new specimen) can be readily derived from that of more typical loxommids. As it happens, one species which can be said to represent a pre-*Spathicephalus* morphological stage is also the only older loxommid known: *Loxomma allmanni* Huxley from the Gilmerton ironstone of Scotland. The Lower Limestone group in which it was found directly underlies the Limestone Coal group in which *Spathicephalus mirus* occurs.

In the transition between the morphological stages represented by *Loxomma* and *Spathicephalus*, posteromedial migration of the orbits has displaced the supraorbital elements so that the frontal bone forms much of the orbital rim — a condition repeated in various genera of labyrinthodonts but more commonly associated with enlarged orbits. Concomitantly the cheek and snout have broadened and flattened into a condition which recalls the early Permian zatracheids *Acanthostoma* and *Zatrachys*. The constriction of the frontals into a narrow bar, together with the

shortening of the skull table, loss of the intertemporal bone and lateral displacement of the postorbital and supratemporal, are unexpected extremes of specialization in so early a genus. Such a condition did not recur, so far as we know, until the development of the plagiosaurs in late Triassic time (cf. Panchen, 1959, fig. 16).

The specializations of *Spathicephalus* evidently adapted it to life as a bottom-dwelling fish-eater. Among labyrinthodonts of this ecotype — e.g. *Erpetosaurus*, *Zatrachys*, *Capitosaurus*, *Eupelor* [*Buettneria*], *Gerrothorax* — the lower jaw articulation tends to be aligned with the occipital condyle, so that the mouth could be opened by raising the snout while the thorax remained prone on the bottom (cf. Watson, 1951, pp. 67-70). A similar tendency is evident in *Spathicephalus*, for its occipital and quadrate condyles are more nearly aligned than those of any other loxommid except the late Westphalian species of *Megalocephalus*.

Surely the extent of modification which *Spathicephalus* had achieved by late Mississippian time presupposes a long previous history — yet to be revealed — for the Loxommidae.

ASSOCIATED FAUNA

A *Gyracanthus* spine, a supposed *Sagenodus* quadrate and fragmentary fish remains were found in the flagstone layer with the mandible of *Pholidoscorpion*(?) *bretonense* in 1956. From this same layer the 1960 field party collected the type of *Spathicephalus pereger* and the proximal third of another *Gyracanthus* spine (PU 17185).

About 12 feet lower in the section, bones coated with red iron oxide occur in an 18-inch zone of highly calcareous mudstone, rich in ostracodes and *Spirorbis*, which is intercalated with layers of limey shale. A *Gyracanthus* spine (PU 17186), a skull bone of the lungfish *Sagenodus* (the left "E" plate, PU 17187), and scales and serap of the crossopterygians *Megalichthys* and *Strep-sodus* (PU 17188, 17189) represent a typical assemblage of Carboniferous fresh-water fishes. Amphibian remains from this horizon include a left clavicle, a phalanx and a ventral scale (PU 17190), all apparently embolomerous.

STRATIGRAPHY

The Point Edward formation is assigned to the lower part of the Canso group. While the Canso cannot yet be correlated precisely with European and other American sequences, it appears

on the basis of fossil floras (Bell, 1944, pp. 23-24) and invertebrates (Copeland, 1957, pp. 6-8) to be more or less equivalent stratigraphically to the Lower Namurian of Europe. Since in current practice the lower boundary of the Upper Carboniferous system coincides with that of the Namurian, the Point Edward formation is classified in European terms as basal Upper Carboniferous. In North America, however, the Carboniferous is subdivided differently: its upper half constitutes the Pennsylvanian system which includes equivalents of the Upper but not the Lower Namurian. Thus the Point Edward formation is classified in American terms as Upper Mississippian (Weller et al., 1948).

The Scottish specimens of *Spathicephalus* were found in the Loanhead No. 2 ironstone of the Midlothian coalfield, a bed which lies in the upper half of the Limestone Coal group (Tulloch and Walton, 1958). This group is believed to be approximately equivalent to Goniatite Zone E₁ (characterized by *Eumorphoceras*) and the lower part of Brachiopod-Coral Zone D₃ (characterized by *Dibunophyllum*); these zones correspond to the Lower Namurian of continental Europe (Trueman, 1954). At the risk of confusion it should be added that although the *Eumorphoceras* Zone forms the base of the Upper Carboniferous, the flora and the fish fauna of this zone show Lower Carboniferous affinities and are separated from their Upper Carboniferous counterparts by a distinct biotic break. The sequence of amphibian-bearing beds in the Scottish Carboniferous has been reviewed by Westoll (1951) and most recently by Panchen and Walker (1961).

In summary, although the correlations involved are still rather tentative on both sides of the Atlantic, current stratigraphic practice assigns an early Namurian age to both the Scottish and Nova Scotian species of *Spathicephalus*. The epoch in which they lived was evidently one of biotic transition between the earlier and later phases of the Carboniferous.

In view of the stratigraphers' uncertainty, the possible utility of *Spathicephalus* as an index fossil is worth investigating. For the most part the loxommid amphibians are too imperfectly known for their distribution to be stratigraphically significant. The best-known genus, *Megaloccephalus* [*Orthosaurus*], ranges through early and middle Pennsylvanian time, i.e. from Westphalian substage A to late Westphalian D (Panchen and Walker, 1961; Baird, 1957). But since *Spathicephalus* is the most extremely specialized member of the family it may have existed over a comparatively short span of geologic time.

SUMMARY

A partial skull roof of the loxommid labyrinthodont *Spathicephalus*, previously known only from the Limestone Coal group of Scotland, has been found in the Point Edward formation of the Canso group near Sydney, Nova Scotia. The suture pattern (hitherto incompletely known) of this extremely specialized genus is described and derived from that of more typical loxomids. *Spathicephalus*-bearing beds of Scotland and Nova Scotia are considered to be early Namurian in age, corresponding to the base of the Upper Carboniferous in Europe and the top of the Mississippian system in North America. *S. pereger* n. sp. is the first-described temnospondylous amphibian of Mississippian age from the Western Hemisphere.

ACKNOWLEDGEMENTS

This study owes much to the hospitality and cooperation of Director Donald K. Crowdis and staff members William F. and Jane McNeill Take of the Nova Scotia Museum of Science in Halifax. F. B. Van Houten analyzed the source rock; A. L. Panchen provided most helpful advice on matters of British stratigraphy; Edward S. Belt has generously shared the results of his current research on Canso stratigraphy and sedimentation. Financial support from the William Berryman Scott Research Fund of Princeton University (administered by Glenn L. Jepsen) and the National Science Foundation made possible the field work.

REFERENCES

BAIRD, DONALD

1957. Rhachitinous vertebrae in the loxommid amphibian *Mcgathicephalus* [abstract]. Geol. Soc. America Bull., vol. **68**, p. 1698.

BELL, W. A.

1944. Carboniferous rocks and fossil floras of northern Nova Scotia. Canada Geol. Survey Mem. no. **238**, 277 pp., 79 pls.

COPELAND, M. J.

1957. The arthropod fauna of the Upper Carboniferous rocks of the Maritime Provinces. Canada Geol. Survey Mem. no. **286**, 110 pp., 21 pls.

PANCHEN, A. L.

1959. A new armoured amphibian from the Upper Permian of East Africa. Roy. Soc. London Phil. Trans. (B), vol. **242**, pp. 207-281, pl. 8.

— AND A. D. WALKER

1961. British Coal Measure labyrinthodont localities. *Ann. Mag. Nat. Hist.*, ser. 13, vol. **3**, pp. 321-332.

ROMER, A. S.

1941. Earliest land vertebrates of this continent. *Science*, vol. **94**, p. 279.
1945. *Vertebrate paleontology*. Univ. Chicago Press, ix + 687 pp.
1947. Review of the Labyrinthodontia. *Mus. Comparative Zool. Bull.*, vol. **99**, pp. 1-368.
1958. An embolomere jaw from the Mid-Carboniferous of Nova Scotia. *Mus. Comparative Zool. Breviora*, No. **87**, 8 pp.

— AND R. V. WITTER

1942. *Edops*, a primitive rhachitinous amphibian from the Texas Red Beds. *Jour. Geol.*, vol. **50**, pp. 925-960.

TRUEMAN, ARTHUR (ED.)

1954. *The coalfields of Great Britain*. London: Edward Arnold, xi + 396 pp., 7 pls.

TULLOCH, W., AND H. S. WALTON

1958. The geology of the Midlothian Coalfield. *Geol. Survey Scotland Mem.*, vii + 157 pp., 5 pls.

WATSON, D. M. S.

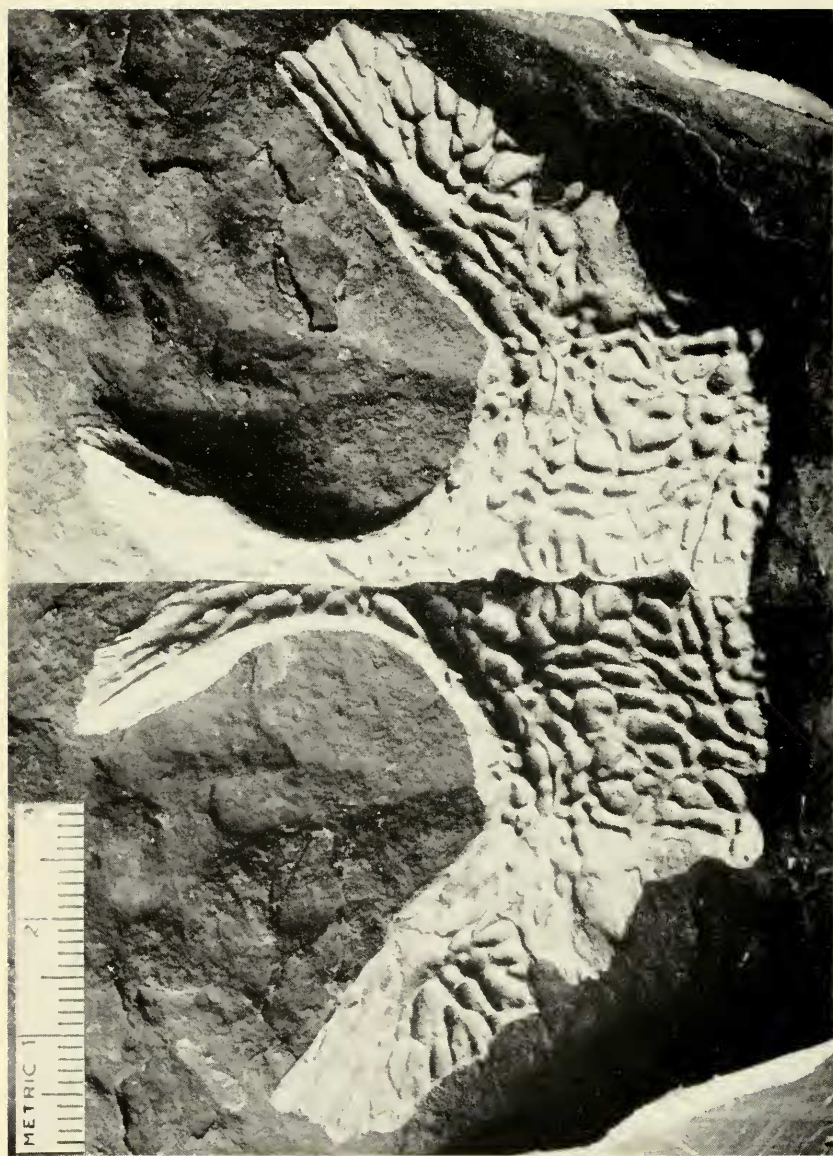
1926. The evolution and origin of the Amphibia. *Roy. Soc. London Phil. Trans. (B)*, vol. **214**, pp. 189-257.
1929 ['1923']. The Carboniferous Amphibia of Scotland. *Palaeontologia Hungarica*, vol. **1**, pp. 219-252, pls. 1-3.
1951. *Paleontology and modern biology*. New Haven: Yale Univ. Press, xii + 216 pp.

WELLER, J. M., ET AL.

1948. Correlation of the Mississippian formations of North America. *Geol. Soc. America Bull.*, vol. **59**, pp. 91-196.

WESTOLL, T. S.

1951. The vertebrate-bearing strata of Scotland. *Internat. Geol. Cong., Rept. 18th Session (11)*, pp. 5-21.



Skull table of *Spathicephalus pereger*, n. sp., from a bicolored latex cast. Left half restored from a photograph which has been illuminated and printed in reverse.